1851MNRAS..11..181D

Mean Places for January 0·1851 of Stars in the Orbit of *Astræa*, deduced from Observations with the Meridian Circle.

R.A.			Precession.	Decl.			Precession.
h	m	s	s	°	′	″	″
14	16	28·20	+3·131	−4	38	35·0	−16·60
	18	43·78	3·135		49	1·1	16·50
	49	27·65	3·136		50	23·5	16·46
	25	18·87	3·138	4	49	12·5	16·15
	25	22·13	3·142	5	7	56·6	16·15
	27	37·53	3·143		10	39·6	16·04
14	31	10·34	+3·144	−5	8	23·4	−15·85

On the Observation of the Solar Spots with large Telescopes.

By the Rev. W. R. Dawes.

"The appearance of the solar spots is greatly modified by the aperture of the telescope employed in observing them. A large aperture, by reducing the telescopic irradiation, produces a hardness and sharpness of outline which cannot be attained by a diminished aperture, and brings out minute details which would never be suspected with a small telescope, however perfect. It may be some time before the admirable suggestion of Sir John Herschel, to make large solar reflecting telescopes with glass mirrors, will be realised, however desirable may be its accomplishment; and even then such instruments will be suited for that purpose only.

"Various methods have been proposed of preserving the darkening glasses, which it is necessary to employ, from the destructive effect of the excessive heat collected by a large object-glass. None of these, as far as I am aware, has proved completely successful. If a combination of coloured glasses is placed at a considerable distance before the eye-piece, so as to receive the rays before they come to focus, according to Mr. Lawson's proposal, the glasses are still exposed to frequent fracture, if the distance from the focus is not very great in proportion to the whole focal length; and if that distance should be much increased, the coloured glasses must be of large size to receive the whole of the rays from the object-glass, and their quality must be nearly as perfect as that of the object-glass itself, or the focal image will be confused and unsatisfactory. But, notwithstanding the objections to the use of this method, its effect on the appearance of the spots and of the sun's disk generally is so striking, as to render it highly desirable that some arrangement should be devised, by which the sun may be examined with an object-glass of the largest dimensions, without the risk of destruction to the coloured glasses, or of injury to the eye of the observer.

"I have lately employed a mode of observation which enables me to use the whole aperture of my 8½-foot refractor (6⅓ inches) without the slightest inconvenience. Its simplicity is such as to render it extremely probable that it may already have been employed by other more diligent observers of the sun than myself; but as I have never met with any hint of it, some other observer

1851MNRAS..11..181D

may perhaps be glad of a suggestion which will save his glasses and secure the safety of his eye; and thus enable him to enjoy without apprehension the extraordinary phenomena which the sun's surface frequently presents when viewed with a large telescope.

"The method consists simply in *diminishing the aperture in the field-bar* of the eye-piece to any extent which the observer may find requisite or convenient. It is obvious that this does not lessen the brightness of the portion of the sun's image which is visible through the aperture of the field-bar; but by diminishing the area from which light and heat are transmitted to the eye, that portion may be viewed with safety, however large may be the aperture of the object-glass. The field-bar, however, being placed at the focus of the object-glass, will receive all the heat concentrated by it, with the exception of the small portion passing through its central aperture; and it will thus very soon become so greatly heated as, by its contact with the interior of the eye-tube, to render the whole of it very inconveniently hot. This I have obviated in my own telescope by letting the field-bar touch the eye-tube in three points only, the rest of its circumference being filed away; and though with this arrangement some heat is still communicated, it is in no inconvenient quantity. But it might probably be almost entirely prevented by setting the field-bar in some substance which is a bad conductor of heat.

"To determine the largest diameter of the aperture in the field-bar which it may be safe to employ, it is only requisite to decide upon the diameter of an object-glass which might certainly be used without danger. I believe that, under the most intense solar heat in this climate, an object-glass of two inches in diameter will not endanger a well-annealed coloured glass; but any smaller diameter may be adopted as the standard; and whatever that may be, the size of the field-bar in any given instance is readily computed.

"Putting O = diameter of the large object-glass in inches and decimals,
F = its focal length similarly expressed,
o = diameter of standard object-glass considered safe to employ,
d = required diameter of field-bar,

we have $$d = \frac{F \times o \times 2 \sin \odot\text{'s } \frac{1}{2} \text{ diameter}}{O}.$$

"Thus, in the case of my own refractor, $O = 6{\cdot}34$; $F = 102{\cdot}5$; and if o be assumed $= 2$ inches, and the sun's semi-diameter $= 16'\ 1''$, we shall have $d = \frac{102{\cdot}5 \times 2 \times {\cdot}00932}{6{\cdot}34} = 0{\cdot}301$.

"By using a field-bar, therefore, whose diameter is three-tenths of an inch, the heat transmitted to the eye-glass is reduced to that which would be received from the whole disk of the sun, if the diameter of the object-glass were reduced to 2 inches. In my refractor, about one-tenth of the sun's area is the proportion embraced by such a field-bar. But though I believe that this does not exceed

1851MNRAS..11..181D

what may be safely admitted, I have usually employed a field-bar of scarcely half that diameter, as being abundantly sufficient for the examination of the largest spots, or even groups of spots.

"In the formula, the eye-piece is supposed to be a convex single lens, or a positive double eye-piece, which, with so small a field of view as the field-bar affords, is quite as convenient as the usual astronomical eye-tube, in which the field lens diminishes the focal image, and in a variable degree with various magnifying powers, necessitating an adjustment of the size of the field-bar to each; while, with the use of single lenses, the power may be varied at pleasure, without changing the dimensions of the field-bar.

"But not only may the minute details of the solar spots be thus examined with all the advantage afforded by the use of a large telescopic aperture. Other very interesting results are also obtainable by the same means. Especially may the heating power of the various parts of the sun's disk be submitted to measurement. And on the occurrence of a solar spot with a large nucleus, by employing a field-bar which would only just embrace that nucleus, the going of the equatoreal driving clock being nicely adjusted, the constitution of the apparently black portion might be examined, and the fact ascertained whether it be actually devoid of light, or whether its light is only so comparatively feeble as to be extinguished by the deep colour of the glass rendered needful by the smallest portion of the sun's bright surface.

"There is one fact to which, though not necessarily connected with the subject of the present paper, I would take this opportunity of drawing attention, as it may, perhaps, be found useful in other observations; and especially in those of some of the phenomena attending a total eclipse of the sun. It is this: *that the same telescopic focus is not equally good on all portions of the sun's surface.* This may be satisfactorily proved when there are well-defined spots near his centre, and also near the edge of his disk: and the difference will be more obvious with a rather low power, such as 40 to 100, on telescopes whose focal length is from 30 to 60 inches. The focus having been accurately adjusted on a spot near the centre, it will be found to require *lengthening* when a spot near the edge is brought into the same part of the field, and *vice versâ.* To ascertain whether this originated in any peculiarity of my own eye, I requested Mr. Hind to try the experiment, without intimating to him on which side the difference of focus lay. He was kind enough to do so, and arrived at precisely the same conclusion as myself. There can therefore be no doubt of the fact; and it is evidently to be attributed to the effect upon the eye of different intensities of light. Indeed I have frequently noticed the same result in passing immediately from one object to another differing much in brightness. Thus, the best focus on the bright edge of the moon will require lengthening when the feebly enlightened portions are brought into the same place in the field of the telescope, or in the examination immediately afterwards of such an object as *Saturn.* And perhaps some of the curious anomalies which have attended

1851MNRAS..11..184D

lunar occultations may partly arise from this source. Observers have often stated that, previous to an occultation, the focus of the telescope has been carefully adjusted on a small and close double star: and if, with that focus, the disappearance of a star be observed at the bright edge of the moon, the probability is that, the greater stimulation of the eye having altered its focus, some clinging to the moon's edge, or even projection on its disk, may be the result. The involuntary shortening of the focus of the eye under the stimulus of light, evidently arises from the diminution of the pupil and the consequent drawing forward of the crystalline lens, and is analogous to the variation produced by looking at near and remote objects: but it is very possible that the amount of variation required in the adjustment of the focus of a telescope may differ with different degrees of sensibility in the eye.

"I would beg leave to suggest to those observers who intend to look out for the delicate phenomena attending a total eclipse of the sun, such as Baily's beads and the red flames in the corona, that it might be well to keep this fact in view, which does not appear to be so generally known as it deserves: at least, among those to whom I have mentioned the subject, there was no one who seemed to be aware of it.

"It would seem highly desirable that this or some other equally efficient method of employing the whole aperture should be adopted in observing the sun's transit with large instruments, and in measuring his diameter with large meridian circles and heliometers. The diameter of the sun, as well as of all other celestial bodies, is unquestionably smaller with a large aperture than with a small one, provided the state of the atmosphere is not too unfavourable for its advantageous employment. Though the difference is not so striking on objects having a sensible diameter as on the disks of the fixed stars, yet it exists; and may be readily subjected to experiment in any large telescope whose whole aperture is sufficiently perfect."

Remarks on the Observations of the Obscure Portion of Saturn's Ring, made by Dr. Galle, at Berlin, in the year 1838. By the Rev. W. R. Dawes.

"In the *Astronomische Nachrichten*, No. 756, there is a paper by Dr. Galle, dated 1851, April 1, in which he refers to a communication of Professor Encke's, published in the *Transactions of the Berlin Academy of Sciences* for 1838, as containing some observations on the dark ring of *Saturn*, made by Dr. Galle with the Berlin refractor, which is, I believe, of the same dimensions as the refractor at Dorpat (aperture 9 inches, and focal length 14 feet, Paris measure), and by the same maker.

"On referring to the volume in the Society's library, I found that no part of it was cut open. Professor Encke's paper is illustrated by two pictures of *Saturn*, in which the exterior ring is shown with a broad division at the ansæ, nearly in the middle of